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Routine childhood vaccination programme coverage, El Salvador, 2011—In search of timeliness

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ABSTRACT

While assessing immunization programmes, not only vaccination coverage is important, but also timely receipt of vaccines. We estimated both vaccination coverage and timeliness, as well as reasons for non-vaccination, and identified predictors of delayed or missed vaccination, for vaccines of the first two years of age, in El Salvador.

We conducted a cluster survey among children aged 23–59 months. Caregivers were interviewed about the child immunization status and their attitudes towards immunization. Vaccination dates were obtained from children immunization cards at home or at health facilities. We referred to the 2006 vaccination schedule for children below two years: one dose of BCG (Bacillus Calmette-Guérin) at birth; rotavirus at two and four months; three doses of pentavalent – DTP (diphtheria-tetanus-pertussis), hepatitis B, and Haemophilus influenzae type b (Hib) – and of oral poliomyelitis vaccine (polio) at two, four, and six months; first MMR (measles-mumps-rubella) at 12 months; and first boosters of DTP and OPV at 18 months. Timeliness was assessed with Kaplan–Meier analysis; Cox and logistic regression were used to identify predictors of vaccination.

We surveyed 2550 children. Coverage was highest for BCG (991%; 95% CI: 98.8–99.5) and lowest for rotavirus, especially second dose (86.3%; 95% CI: 84.2–88.4). The first doses of MMR and DTP had 991% (95% CI: 98.5–99.6) and 977% (95% CI: 970–985), respectively. Overall coverage was 837% (95% CI: 81.4–86.0); 96.4% (95% CI: 95.4–97.5), excluding rotavirus. However, only 26.7% (95% CI: 24.7–28.8) were vaccinated within the age interval recommended by the Expanded Programme on Immunization. Being employed and using the bus for transport to the health facility were associated with age-inappropriate vaccinations; while living in households with only two residents and in the "Paracentral", "Occidental", and "Oriental" regions was associated with age-appropriate vaccinations. Vaccination coverage was high in El Salvador, but general timeliness and rotavirus uptake could be improved.

1. Introduction

Vaccination coverage is usually calculated from the number of vaccinated individuals (numerator) in a specific target group (denominator), without taking into account time of vaccination, unless age-specific cohorts are defined. However, timely receipt of vaccines has important implications for the success of child immunization programmes, since vaccines administered too late may leave children unnecessarily unprotected, while those administered too early may not be effective [1]. To assess age-appropriate vaccination, the Kaplan–Meier method and the Cox regression, which are survival-analysis techniques used to describe time-to-event data, can be applied [2–6].

El Salvador is on the Pacific coast of Central America. Bordering Honduras and Guatemala, it covers an area of 21,040 km^2 and, with a population of 5,744,113 (2009 census), is one of the most densely populated countries in the world. Administratively, it is divided into five regions, 14 departments, and 262 municipalities. It is considered a lower-middle-income country on the basis of 2009 World Bank Gross National Income per capita [7].

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In El Salvador, for children younger than two years, the Expanded Programme for Immunization (EPI) includes the following vaccines: Bacillus Calmette-Guérin (BCG) at birth; rotavirus at two and four months; pentavalent – including diphtheria, tetanus, pertussis (DTP), hepatitis B, and *Haemophilus influenzae* type b – and oral poliomyelitis (polio) at two, four, and six months; the first dose of measles, mumps, and rubella (MMR) at 12 months; and booster (b) of DTP and polio at 18 months (2006/2007 schedule). All vaccines included in the EPI schedule are offered to the population free of charge by the government. Like other countries in the region, El Salvador submits annual administrative coverage data to the Pan American Health Organization (PAHO), the regional office of the World Health Organization [8]. Administrative coverage is calculated dividing the number of vaccine doses administered by the number of children in the target age-group. These calculations are affected by data quality issues, both regarding the denominator (e.g., outdated census) and the numerator (e.g., incomplete/incorrect reporting) [9,10], and do not include information on exact age of vaccination, making it impossible to assess timeliness of administration. Especially in low- and middle-income countries, vaccination coverage surveys are used to assess coverage and compare it with administrative data, while answering specific questions to guide programme strategies [11,12].

Reported administrative coverage of the third dose of DTP (included in the pentavalent in El Salvador), the vaccine generally used to track immunization progress globally [13], has fluctuated between 89% and 100%, in the period 2005–2011 [14]. In November 2011, we conducted a survey among children aged between 23 and 59 months in El Salvador to assess vaccination coverage, timeliness of vaccination, reasons for non-vaccination, and predictors of delayed or missed vaccination, for the vaccines recommended during the first two years of age.

2. Methods

2.1. Survey design

Between 1 November and 2 December 2011, we conducted a household-based cluster survey [15] among children aged 23–59 months living in El Salvador. We chose this age range so that all participants had the chance of having a complete vaccination schedule including the first booster doses of polio and DTP. To reach regional estimates of coverage with 5% precision and 95% confidence interval (CI), assuming coverage at 80% and a design effect of 2, the minimum sample size required in each region was 510 children, divided in 30 clusters of 17, corresponding to 2550 children in the entire country.

2.2. Sampling in the field

We randomly selected clusters of 17 households from the list of municipalities by region, according to probability proportional to population size (PPS) [16]. In each selected municipality, we randomly selected one locality (i.e., a suburb or a neighbourhood in urban areas or a village in rural areas) by simple random ballot from the list of all localities in the municipality. In the locality, we followed two different procedures to select the first household of each cluster. In urban areas, we numbered the squares in which the locality was divided and selected one randomly; we then numbered the dwellings in the selected square and selected one randomly to start the survey. In rural areas, we selected a sector and then the starting household in the sector from the map of the locality available from the local health facility. We selected the subsequent 16 households, by turning to the right while exiting the household and visiting the adjacent households. Only one eligible child per household was randomly selected for the survey. Households with no eligible children or that appeared permanently vacant were excluded. Households in which it appeared that someone was living, but no one was responding, were scheduled for one revisit at a different time. If we could not complete the cluster in the selected locality, we moved to the closest locality in the same municipality and repeated the procedure to select the remaining households. All simple random selections in the field were done using the table of random numbers.

2.3. Data collection and entry

After obtaining verbal consent, trained surveyors interviewed the caregivers and transcribed information from the immunization cards of the selected children, using a standard questionnaire (available as supplementary online material). We collected information on socio-demographic factors, divided into broad categories: place of residence, demographics, household characteristics, attitudes of the caregiver towards vaccination, and reasons for non-vaccination. If the immunization card was not available, surveyors sought vaccination history from the immunization record available at the local health establishment where the child was vaccinated. Data were entered onto a computerized form designed in SPSS (IBM Corp. 2011, SPSS Statistics, Armonk, NY, USA).

2.4. Outcome measures

We considered as not vaccinated any child without evidence of having received specific vaccinations from the immunization cards or whose caregiver did not present the immunization card and for whom no evidence on vaccination was found in the public immunization record. To assess delays in vaccination, we used the recommended vaccination schedule for children less than two years old in El Salvador in 2006/2007.

We considered three, progressively narrower, definitions of vaccination coverage: (1) general coverage, defined as the proportion of children having received vaccines, independent of their age at vaccination; (2) acceptable timing, defined as having received vaccines scheduled in the first year of life before 365 days of age (except rotavirus vaccine, for which the maximum age was 209 days) or ones scheduled in the second year of life between 355 (except MMR for which the minimum age was set at 270 days) and 729 days of age with an interval of at least 28 days between subsequent doses containing the same antigen; and (3) age-appropriate vaccination, defined as being vaccinated according to the EPI schedule, namely having received BCG between 0 and 30 days of age, two rotavirus vaccines, the first dose starting from 60 and the last one up to 149 days, three pentavalent and polio vaccines, the first dose starting from 60 and the last one up to 209 days, MMR between 365 and 395 days, and DTP1b and polio1b between 450 and 575 days, and with an interval of at least 28 days between subsequent doses containing the same antigen.

2.5. Statistical analysis

We used STATA 10 (StataCorp. 2007, Stata Statistical Software, College Station, TX, USA) for the analysis, applying the “svyset” command for complex survey designs with regional population size and number of eligible children living in the households as survey weights to account for differences in probability of selection. We assumed that data were approximately self-weighted within each cluster selected with PPS. We calculated vaccination coverage estimates with 95% CI. For each vaccine, we estimated the cumulative probability of being vaccinated at age t, by inverse Kaplan–Meier survival function, or $1 - S_{KM}(t)$ [17] and we assessed at what age